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TRICYCLIC DITERPENOIDS FROM THE STEM BARK OF *AZADIRACHTA INDICA*

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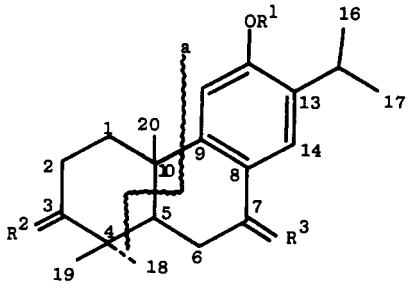
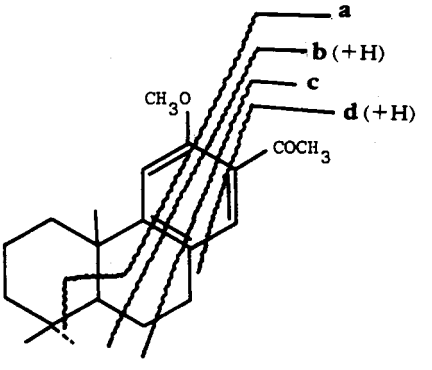
ABSTRACT.—Nimosone, nimbosone, methyl nimbiol, and methyl nimbionone, four new tricyclic diterpenoids, have been isolated from the stem bark of *Azadirachta indica* along with sugiol. The structures of the new constituents have been elucidated as 12-hydroxy-8,11,13-abietatriene-3,7-dione [**1**], 13-acetyl-12-methoxy-8,11,13-podocarpatriene [**5**], 12-methoxy-13-methyl-8,11,13-podocarpatrien-7-one [**6**], and 12,13-dimethoxy-8,11,13-podocarpatriene-3,7-dione [**7**], respectively, through chemical and spectral studies. Compounds **6** and **7** have previously been reported only as reaction products.

Azadirachta indica A. Juss. (Meliaceae), commonly known as "neem," is indigenous to the Indo-Pakistan subcontinent. Almost every part of the tree has been used for the treatment of a variety of human ailments, particularly against diseases of bacterial and fungal origin (1,2). The bark is regarded as a bitter tonic, astringent, and useful in fever, thirst, nausea, vomiting, and skin diseases (3). Recent studies have revealed that various fractions derived from neem possess such diverse biological effects as insect repellence, phagodeterrence, reduction of growth, abnormal development, and reduction of oviposition (4,5). Moreover, it has been found that polysaccharides isolated from neem bark have strong anti-inflammatory (6) and antitumor action (6,7). More recently, an antineoplastic drug has also been obtained from the bark (8).

In the present studies on the constituents of neem stem bark the four new tricyclic diterpenoids nimosone, nimbosone, methyl nimbiol, and methyl nimbionone have been isolated, along with the known phenolic diterpene sugiol (9,10). The structures of the new constituents have been elucidated as 12-hydroxy-8,11,13-abietatriene-3,7-dione [**1**], 13-acetyl-12-methoxy-8,11,13-podocarpatriene [**5**], 12-methoxy-13-methyl-8,11,13-podocarpatrien-7-one [**6**], and 12,13-dimethoxy-8,11,3-podocarpatriene-3,7-dione [**7**] through chemical transformations and spectroscopic methods. It may be noted that various tricyclic diterpenes reported in the literature possess a wide range of biological activity including hypocholesterolemic (11), antitumor (12), antileukemic (13), and antibiotic activity (14), plant cell expansion and cell division inhibition (15,16), and insecticidal properties (4,5).



	R^1	R^2	R^3
1	H	O	O
2	Me	O	O
3	Ac	O	O
4	Ac	β-OH	α-OH
		α-H	β-H



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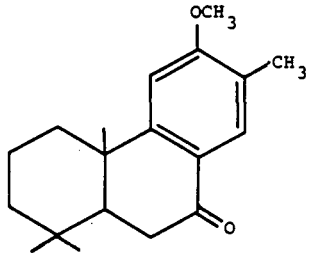
RESULTS AND DISCUSSION

The residue obtained from the EtOH extract of the stem bark was divided into acidic and neutral fractions. The acidic fraction yielded nimosone [**1**] and sugiol [**8**], whereas the neutral fraction furnished nimbosone [**5**], methyl nimbiol [**6**], and methyl nimbionone [**7**].



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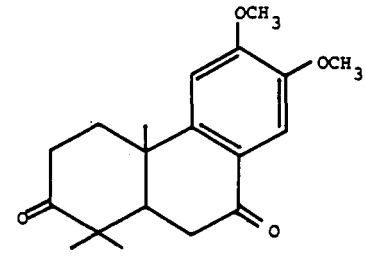

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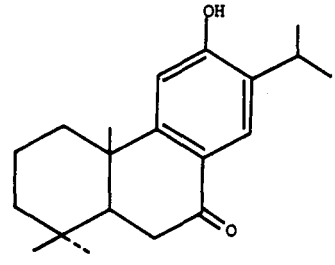

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The mass spectrum of nimosone [**1**] showed that it has the molecular formula $C_{20}H_{26}O_3$. Its uv spectrum contained absorptions at 218, 230, 280, and 300 nm, while the ir spectrum displayed peaks at 3600–3100 (OH), 2900 (C-H), 1710–1680 (six-membered and α,β-unsaturated carbonyls), and 1600 cm^{-1} (aromatic ring).

The ^{1}H-nmr spectrum showed three singlets of three protons each at δ 1.13 (4α-Me), 1.19 (4β-Me), and 1.43 (10-Me). Two one-proton singlets were observed at δ 6.66 and δ 7.93 attributable to the olefinic protons at C-11 and C-14, respectively. A one-proton-seven-line pattern at δ 3.13 (J = 7.12 Hz) and a six-proton doublet at δ 1.28 (J = 7.12 Hz) showed the presence of an isopropyl group. The presence of a hydroxy function, indicated by the ir spectrum (ν max 3600–3100 cm^{-1}) and a fragment in the mass spectrum at *m/z* $[M - Me - H_2O]^+$ 281, was confirmed by methylation with CH_2N_2, acetylation, and the ^{13}C-nmr spectrum ($\delta_{C\text{-}12}$ 158.7). The ^{13}C-nmr spectrum (broad band and DEPT) further showed that **1** has two ketonic carbonyls, one of which is conjugated with the aromatic ring, two tertiary and four quaternary olefinic carbons (of the aromatic ring), five methyls, three methylenes, two methines, and two saturated quaternary carbons. These data and calculation of the double bond equivalents indicated that nimosone [**1**] has a tricyclic abietane skeleton.

One of the carbonyl functions was placed at C-7 in light of the chemical shifts of H-11, H-14, and C-7 (δ 197.0), which are comparable with those reported for sugiol [**8**] (Tables 1 and 2) (17,18). A significant fragment at *m/z* 125.0965 (fragment **a**, $C_8H_{13}O$) in the mass spectrum (19) and the downfield appearance of 10-Me (δ 1.43) (20) as compared to that of sugiol suggested the location of the second carbonyl at C-3. These data showed that nimosone is closely related to sugiol and led to the assignment

TABLE 1. ^{1}H-nmr Spectral Data (δ_H and J/Hz) of Compounds **1–8**.

Proton	Compound							
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
H-1α	2.01 ddd J_{gem} = 13.00 $J_{1\alpha,2\beta}$ = 13.00 $J_{1\alpha,2\alpha}$ = 5.51	1.96–2.03 m	2.01 ddd J_{gem} = 16.76 $J_{1\alpha,2\beta}$ = 12.24 $J_{1\alpha,2\alpha}$ = 5.70	2.03–2.16 m	1.21–170 m	1.50–2.40 m	2.02 ddd J_{gem} = 12.90 $J_{1\alpha,2\beta}$ = 12.40 $J_{1\alpha,2\alpha}$ = 5.58	1.67 ddd J_{gem} = 13.68 $J_{1\alpha,2\beta}$ = 7.16 $J_{1\alpha,2\alpha}$ = 3.92
H-1β	2.64–2.68 m	2.63–2.68 m	2.68 ddd J_{gem} = 16.75 $J_{1\beta,2\beta}$ = 5.40 $J_{1\beta,2\alpha}$ = 3.61	2.63–2.67 m	1.21–1.70 m	1.50–2.40 m	2.73 ddd J_{gem} = 12.90 $J_{1\beta,2\alpha}$ = 6.41 $J_{1\beta,2\beta}$ = 6.41	2.70 ddd J_{gem} = 13.68 $J_{1\beta,2\alpha}$ = 4.28 $J_{1\beta,2\beta}$ = 3.60
H-2α	2.53 ddd J_{gem} = 15.70 $J_{2\alpha,1\alpha}$ = 5.51 $J_{2\alpha,1\beta}$ = 3.40	2.53–2.54 m	2.54 ddd J_{gem} = 15.81 $J_{2\alpha,1\alpha}$ = 5.70 $J_{2\alpha,1\beta}$ = 3.61	2.27–2.31 m	1.21–1.70 m	1.50–2.40 m	2.57 ddd J_{gem} = 16.12 $J_{2\alpha,1\beta}$ = 7.50 $J_{2\alpha,1\alpha}$ = 5.58	2.50–2.55 m
J-2β	2.83–2.85 m	2.85–2.88 m	2.63 ddd J_{gem} = 15.81 $J_{2\beta,1\alpha}$ = 12.24 $J_{2\beta,1\beta}$ = 5.40	2.63–2.67 m	1.21–1.70 m	1.50–2.40 m	2.84 ddd J_{gem} = 16.12 $J_{2\beta,1\alpha}$ = 12.40 $J_{2\beta,1\beta}$ = 6.41	1.81–1.87 m
H-3α	—	—	—	3.33–3.35 m h/2 = 20.4 Hz	1.21–1.70 m	1.50–2.40 m	—	1.73 ddd J_{gem} = 14.30 $J_{3\alpha,2\beta}$ = 6.84 $J_{3\beta,2\alpha}$ = 3.60
H-3β	—	—	—	—	1.21–1.70 m	1.50–2.40 m	—	2.23 ddd J_{gem} = 14.30 $J_{3\beta,2\beta}$ = 3.60 $J_{3\beta,2\alpha}$ = 2.34
H-5	2.30 dd $J_{5,6\beta}$ = 13.92 $J_{5,6\alpha}$ = 3.72	2.27–2.30 m	2.30 dd $J_{5,6\beta}$ = 13.84 $J_{5,6\alpha}$ = 3.80	2.29 m	1.85 dd $J_{5,6\beta}$ = 11.50 $J_{5,6}$ = 3.84	1.85 dd $J_{5,6\beta}$ = 13.40 $J_{5,6\alpha}$ = 4.32	2.34 dd $J_{5,6\beta}$ = 13.70 $J_{5,6\alpha}$ = 3.90	2.30 dd $J_{5,6\beta}$ = 13.00 $J_{5,6\alpha}$ = 4.52
H-6α	2.62 dd J_{gem} = 17.60 $J_{6\alpha,5}$ = 3.72	2.64–2.65 m	2.65 dd J_{gem} = 17.76 $J_{6\alpha,5}$ = 3.80	2.25–2.35 m	2.62–2.70	2.69 dd J_{gem} = 18.04 $J_{6\alpha,5}$ = 4.32	2.63 dd J_{gem} = 17.60 $J_{6\alpha,5}$ = 3.90	2.60 dd J_{gem} = 18.00 $J_{6\alpha,5}$ = 4.52

TABLE 1. Continued.

H-6β	2.72 dd J_{gem} = 17.60 $J_{6\beta,5}$ = 13.92	2.77–2.79 m	2.78 dd J_{gem} = 17.76 $J_{6\beta,5}$ = 13.84	2.25–2.35 m	2.62–2.70 m	2.58 dd J_{gem} = 18.04 $J_{6\beta,5}$ = 13.40	2.77 dd J_{gem} = 17.60 $J_{6\beta,5}$ = 13.70	2.72 dd J_{gem} = 18.0 $J_{6\beta,5}$ = 13.0
H-7α	—	—	—	—	2.50–2.70 m	—	—	—
H-7β	—	—	—	4.21 dd $J_{7\beta,6\beta}$ = 5.90 $J_{7\beta,6\alpha}$ = 3.70	2.50–2.70 m	—	—	—
H-11	6.66 s	6.66 s	6.98 s	6.64 s	6.85	6.72 s	6.75 s	6.67 s
H-14	7.93 s	7.93 s	8.01 s	7.89	7.79 s	7.80 s	7.51 s	7.90 s
H-15	3.13 h J = 7.12	3.13 h J = 6.96	2.99 h J = 6.99	3.11 h J = 6.90	—	—	—	3.11 h J = 6.91
H-16 H-17	1.28 d J = 7.12	1.28 d J = 6.96	1.28 d J = 6.99	1.27 d J = 6.90	—	—	—	1.28 d J = 6.91
H-18	11.3 s	1.13 s	1.13 s	0.87 s	1.12 s	0.87 s	1.14 s	0.92
H-19	1.19 s	1.19 s	1.19 s	0.95 s	1.15 s	0.93 s	1.20 s	0.98 s
H-20	1.43 s	1.44 s	1.42 s	1.03 s	1.27 s	0.99 s	1.44 s	1.21 s
OAc	—	—	2.34 s	2.23 s	—	—	—	—
OMe	—	3.97 s	—	—	3.90 s	3.91 s	3.92 s, 3.94 s	—
Ac	—	—	—	—	2.23 s	—	—	—
Me	—	—	—	—	—	2.18 s	—	—

TABLE 2. ^{13}C-nmr Chemical Shifts (δ_C/ppm) of Compounds **1** and **8**.

Carbon	Compound	
	1	Sugiol [**8**][a]
C-1	36.9	37.3
C-2	34.5	18.4
C-3	214.4	40.9
C-4	47.4	32.7
C-5	49.6	49.1
C-6	36.2	35.4
C-7	197.0	199.2
C-8	124.2	122.4
C-9	153.7	156.3
C-10	36.9	37.4
C-11	110.4	109.0
C-12	158.7	160.3
C-13	133.6	133.0
C-14	126.8	125.6
C-15	26.9	26.1
C-16	22.3	21.8
C-17	22.4	21.6
C-18	21.5[b]	31.9
C-19	25.0[b]	20.7
C-20	22.3[b]	22.5

[a]Values in this column are from Wenkert *et al.* (18).
[b]Values may be interchanged.

of structure **1** for this compound. The connectivity of H-15 with H-16 and H-17, H-2α with H-2β and H-1α, and H-5 with H-6α and H-6β was confirmed through ^1H-^1H homonuclear decoupling experiments and a COSY-45 plot.

Placement of the hydroxyl and isopropyl groups at C-12 and C-13, respectively, assignment of the C-methyl groups, and the stereochemistry of the various centers of nimosone [**1**] were established through 2D NOESY spectral analysis, which showed the spatial connectivities of H-16 and H-17 with H-14, H-2β with H-1β and H-6β with H-6α. The interaction of H-5 with both 4β-Me and 4α-Me indicates that ring A is in a twist-boat conformation. Chemical evidence regarding the carbonyl functions in **1** was obtained through $NaBH_4$ reduction of the acetyl deviative **3** to the diol **4**.

Nimbosone [**5**] has the molecular formula $C_{20}H_{28}O_2$ (hrms $[M]^+$ 300.2092). The uv spectrum exhibited absorptions at 208, 228, and 280 nm while the ir spectrum displayed peaks at 2900 (C-H), 1700 (carbonyl), and 1590 cm^{-1} (aromatic ring). In the ^1H-nmr spectrum two downfield one-proton singlets observed at δ 6.85 and δ 7.79 have been attributed to H-11 and H-14, respectively. Two three-proton singlets at δ 3.90 and δ 2.23 were ascribed to OMe and the acetyl methyl, respectively. This assignment is supported by the fragments in the hrms at *m/z* 242.1678 $[M - Me - Ac]^+$ and *m/z* 196.1264 $[M - Ac - Me - 2 \times Me]^+$.

The appearance of the aromatic protons as singlets showed that the two substituents are located at C-12 and C-13. In view of the downfield resonance of the angular methyl (δ 1.27) from the normal values (δ 1.13–1.20) for diterpenoids lacking a polar para substituent or a C-7 carbonyl function, the polar substituent (Ac) in **5** was placed at C-13, i.e., para to the carbon bearing the angular methyl group (21). This assignment is supported by the appearance of fragments **a–d** in the hrms. Nimbosone [**5**] is the first naturally occurring aromatic tricyclic diterpenoid with an acetyl group on any one of

the aromatic carbons, although such methyl ketones have been prepared from podocarpanoids (22).

The mass spectrum of methyl nimbiol [**6**] shows it has molecular formula $C_{19}H_{26}O_2$. Its ir spectrum displayed peaks at 2850 (C-H), 1710 (carbonyl), and 1600 cm^{-1} (aromatic ring). The molecular formula shows that there are 7 double bond equivalents in the molecule, 4 of which are accounted for by the aromatic ring, one by the carbonyl function, and two by the remaining two rings of the skeleton. The diterpenoid nature of **6** was indicated by the molecular formula and the presence in the ^{1}H-nmr spectrum of three three-proton singlets at δ 0.87, 0.93, and 0.99. The appearance of the aromatic protons as singlets at δ 6.72 and 7.80 suggested the presence of two substituents shown by the ^{1}H-nmr spectrum to be OMe and Me (δ 3.91 and 2.18, respectively). Their positions at C-12 and C-13 were confirmed by the NOESY spectrum which showed connectivities between the OMe protons and H-11 and between the aromatic methyl protons and H-14. A close analogy of the data above with those of nimbiol (10,17) led to the methyl nimbiol structure **6** for the natural product, which was confirmed by comparison with authentic material prepared by methylation of nimbiol using CH_2N_2.

The uv spectrum of methyl nimbionone [**7**], $C_{19}H_{24}O_4$, showed absorptions at 206, 232, 278, and 308 nm, and the ir spectrum contained peaks at 2850 (C-H), 1720–1680 (br) (six-membered, α,β-unsaturated ketone), 1660–1560 (aromatic double bond), and 1280 cm^{-1} (C-O). The ^{1}H-nmr spectrum showed three three-proton singlets at δ 1.14, 1.20, and 1.44 and two aromatic protons as singlets at δ 6.75 (H-11) and 7.51 (H-14). The molecular formula and the ^{1}H-nmr spectrum indicated that **7** is also a tricyclic aromatic diterpenoid. The substituents at C-12 and C-13 are both OMe (δ 3.91, 3.94, 2 × OMe) while the position of one of the carbonyl groups at C-7 was suggested by the downfield chemical shift of H-14. The chemical shifts of the quaternary methyl protons, particularly the downfield shift of H-20 (21), which are comparable with those of nimosone [**1**], showed that the other carbonyl function is located at C-3.

It may be noted that **6** and **7** have earlier been obtained by methylation of nimbiol (10) and nimbionone (23), respectively, but this is the first report of their isolation as natural products.

Sugiol was identified through comparison of its spectral data with those previously reported (10,17,18).

EXPERIMENTAL

GENERAL EXPERIMENTAL PROCEDURES.—Melting points were recorded on an air-bath type melting point apparatus and are uncorrected. Ir (in $CHCl_3$) and uv (in MeOH) spectra were measured on JASCO-IRA-I and Pye-Unicam SP-800 spectrometers, respectively; ms were recorded on a Finnigan MAT 311A double focusing mass spectrometer; ^{1}H-nmr spectra were recorded in $CDCl_3$ on a Bruker Aspect AM 400 spectrometer operating at 400 MHz. ^{13}C-nmr (broad band and DEPT) spectra were recorded in $CDCl_3$ on a Bruker Aspect-300 spectrometer operating at 75 MHz. The assignments of ^{13}C-nmr chemical shifts are based on chemical shift rules (24) and comparison with those of similar compounds (18,25). Merck Kieselgel 60 PF_{254} and Al_2O_3 60 PF_{254} coated on glass plates were used for analytical (thin layer) and preparative (thick layer) chromatography.

PLANT MATERIAL.—Neem bark (1.7 kg) was collected from the Karachi region during February and identified by professor S.I. Ali, Department of Botany, University of Karachi. A voucher specimen (No. NM-1) has been deposited in the Herbarium of the Botany Department, University of Karachi.

EXTRACTION AND ISOLATION.—The neem stem bark (1.7 kg) was repeatedly percolated with EtOH at room temperature, the EtOH was removed, and the residue was partitioned between EtOAc and H_2O. The organic layer was shaken with 4% Na_2CO_3 solution to separate the acidic from the neutral constituents. The EtOAc phase was washed, dried (anhydrous Na_2SO_4), charcoaled, and filtered. The residue obtained on removal of the solvent was divided into hexane-soluble and hexane-insoluble fractions. The

latter was taken up in EtOAc and treated with an excess of hexane to afford an EtOAc-hexane-soluble and an EtOAc-hexane-insoluble fraction. The former on preparative tlc [Al_2O_3, hexane-EtOAc (8.5:1.5)] furnished methyl nimbiol [**6**] and methyl nimbionone [**7**]. The hexane-EtOAc-insoluble fraction was subjected to flash cc (26) [hexane-EtOAc (9:1)] to give four major fractions (A–D). Fraction D on preparative tlc [Si gel, $CHCl_3$-MeOH (9.75:0.25)] yielded nimbosone [**5**]. The aqueous Na_2CO_3 phase referred to above was acidified (30% HCl) and shaken with EtOAc. The residue obtained on removal of solvent from the washed and dried EtOAc phase was divided into hexane-soluble and hexane-insoluble portions. The latter on preparative tlc [Si gel, $CHCl_3$-MeOH (9.75:0.25)] gave crude **1** which was purified by chromatography on precoated thin layer plates [Si gel, $CHCl_3$-MeOH (9.5:0.5)]. The hexane-soluble portion on thick layer chromatography [Si gel, hexane-EtOAc (8:2)] furnished sugiol [**8**] along with some minor constituents.

NIMOSONE [**1**].—Needles (14.5 mg) from $CHCl_3$, mp 72–73°; uv λ max 218, 230, 280, 300 nm; ir ν max 3600–3100, 2900, 1710–1680, 1600 cm^{-1}; eims *m/z* (%) $[M]^+$ 314.1889 (30), calcd for $C_{29}H_{26}O_3$, 314.1881; $[M-Me]^+$ 299.1647 (33), $[M-C_2H_4]^+$ 286.1596 (12), $[M-Me-H_2O]^+$ 281.1541 (7), $[M-C_3H_5O]^+$ 257.1541 (13), $[M-C_5H_9O]^+$ 299.1228 (25), $[M-C_6H_{10}O-Me]^+$ 201.0915 (25), $[M-C_{12}H_{13}O_2]^+$ 125.0965 (100).

METHYLATION OF NIMOSONE [**1**].—A solution of nimosone (4.5 mg) in Et_2O was treated with freshly prepared CH_2N_2 at room temperature for 6 h and evaporated to dryness under reduced pressure. The methylated product **2** crystallized from MeOH as irregular plates (2.8 mg), mp 113–114°; ir ν max 1725–1700 (carbonyls), 1600 cm^{-1} (aromatic ring); eims *m/z* (%) $[M]^+$ 328 (2), $[M-15]^+$ 313 (2.5), 282 (1), 215 (2), 125 (16), 57 (100).

ACETYLATION OF NIMOSONE [**1**].—To a solution of **1** (6.5 mg) in pyridine (1 ml), Ac_2O (2 ml) was added and the reaction mixture kept overnight at room temperature. The acetylated product **3** (6.1 mg) obtained on usual workup crystallized from $CHCl_3$ as irregular plates, mp 168–169°; uv λ max 219, 255, 300 nm; ir ν max 2850 (C-H), 1720 (carbonyls), and 1600 cm^{-1} (aromatic ring); eims *m/z* (%) [M] 356 (12), $[M-42]^+$ 314 (100), 299 (34), 257 (12), 229 (19), 201 (10), and 125 (10).

REDUCTION OF ACETYL NIMOSONE **3** WITH $NaBH_4$.—Acetyl nimosone (4.5 mg) [**3**] was dissolved in MeOH and treated with excess $NaBH_4$. The reaction mixture was kept stirring for 7 h, diluted with H_2O, and shaken with EtOAc. The residue obtained on removal of solvent from the EtOAc phase was dissolved in hexane and kept at room temperature overnight to furnish elongated rods of the reduction product **4** (2.5 mg), mp 103°–104°; uv λ max 205, 235, 280 nm; ir ν max 3500–3100 (OH), 1720–1700 (carbonyls), 1600 cm^{-1} (aromatic ring); eims *m/z* (%) $[M-OAc]^+$ 301 (0.32), 203 (3), 69 (100).

NIMBOSONE [**5**].—Needles (5.5 mg) from hexane, mp 137–139°; uv λ max 208, 228, 280 nm; ir ν max 2900 (C-H), 1700 (carbonyl), 1590 cm^{-1} (aromatic ring); hrms *m/z* (%) $[M]^+$ 300.2092 (6.2), $[M-Me]^+$ 285.1850 (4.5), $[M-Me-AC]^+$ 242.1678 (0.42), $[M-AC-Me-Me]^+$ 227.1409 (0.87), $[M-Ac-OMe-2\times Me]^+$ 196.1264 (0.43), $[M-C_{10}H_{17}O]^+$ 147.0864 (4.7), $[C_8H_9O$, fragment **a**$]^+$ 121.0679 (0.59), $[C_7H_9O$, fragment **b**$]^+$ 109.0671 (0.37), $[C_6H_6O$, fragment **c**$]^+$ 94.0367 (0.50), $[C_4H_5O$, fragment **d**$]^+$ 69.0337, $[C_4H_9]^+$ 57.0703 (100).

METHYL NIMBIOL [**6**].—Irregular plates (5.6 mg) from hexane, mp 142–143°; ir ν max 2850, 1710, 1600 cm^{-1}; eims *m/z* (%) $[M]^+$ 286.1929 (30) (calcd for $C_{19}H_{26}O_2$, 286.1932); $[M-Me]^+$ 271.1679 (30), $[M-C_6H_{11}]^+$ 203.1071 (25), $[M-C_{10}H_{16}]^+$ 150.0680 (26), $[C_4H_7]^+$ 55 (100).

METHYL NIMBIONONE [**7**].—Needles (12.4 mg) from hexane, mp 116–119°; uv λ max 206, 232, 278, 308 nm; ir ν max 2850 (C-H), 1720–1680 br (carbonyls) 1660–1560 (aromatic double bond) and 1280 cm^{-1}(C-O); eims *m/z* $[M]^+$ 316 (100%), $[M-Me]^+$ 301 (38), $[M-Me-H_2O]^+$ 283 (18), $[M-C_2H_3O]^+$ 273 (24), $[C_8H_{13}O]^+$ 125 (60).

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